Magnetic Resonance Imaging of Cardiac Strain Pattern Following Transplantation of Human Tissue Engineered Heart Muscles.

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Public Summary:

The use of tissue engineering approaches in combination with exogenously produced cardiomyocytes offers the potential to restore contractile function after myocardial injury. However, current techniques assessing changes in global cardiac performance after such treatments are plagued by relatively low detection ability. Since the treatment is locally performed, this detection could be improved by myocardial strain imaging that measures regional contractility. METHODS AND RESULTS: Tissue engineered heart muscles (EHMs) were generated by casting human embryonic stem cell-derived cardiomyocytes with collagen in preformed molds. EHMs were transplanted (n=12) to cover infarct and border zones of recipient rat hearts 1 month after ischemia reperfusion injury. A control group (n=10) received only sham placement of sutures without EHMs. To assess the efficacy of EHMs, magnetic resonance imaging and ultrasound-based strain imaging were performed before and 4 weeks after transplantation. In addition to strain imaging, global cardiac performance was estimated from cardiac magnetic resonance imaging. Although no significant differences were found for global changes in left ventricular ejection fraction (control -9.6±1.3% versus EHM -6.2±1.9%; P=0.17), regional myocardial strain from tagged magnetic resonance imaging was able to detect preserved systolic function in EHM-treated animals compared with control (control 4.4±1.0% versus EHM 1.0±0.6%; P=0.04). However, ultrasound-based strain failed to detect any significant change (control 2.1±3.0% versus EHM 6.3±2.9%; P=0.46). CONCLUSIONS: This study highlights the feasibility of using cardiac strain from tagged magnetic resonance imaging to assess functional changes in rat models following localized regenerative therapies, which may not be detected by conventional measures of global systolic performance.

Scientific Abstract:

BACKGROUND: The use of tissue engineering approaches in combination with exogenously produced cardiomyocytes offers the potential to restore contractile function after myocardial injury. However, current techniques assessing changes in global cardiac performance after such treatments are plagued by relatively low detection ability. Since the treatment is locally performed, this detection could be improved by myocardial strain imaging that measures regional contractility. METHODS AND RESULTS: Tissue engineered heart muscles (EHMs) were generated by casting human embryonic stem cell-derived cardiomyocytes with collagen in preformed molds. EHMs were transplanted (n=12) to cover infarct and border zones of recipient rat hearts 1 month after ischemia reperfusion injury. A control group (n=10) received only sham placement of sutures without EHMs. To assess the efficacy of EHMs, magnetic resonance imaging and ultrasound-based strain imaging were performed before and 4 weeks after transplantation. In addition to strain imaging, global cardiac performance was estimated from cardiac magnetic resonance imaging. Although no significant differences were found for global changes in left ventricular ejection fraction (control -9.6+/-1.3% versus EHM -6.2+/-1.9%; P=0.17), regional myocardial strain from tagged magnetic resonance imaging was able to detect preserved systolic function in EHM-treated animals compared with control (control 4.4+/-1.0% versus EHM 1.0+/-0.6%; P=0.04). However, ultrasound-based strain failed to detect any significant change (control 2.1+/-3.0% versus EHM 6.3+/-2.9%; P=0.46). CONCLUSIONS: This study highlights the feasibility of using cardiac strain from tagged magnetic resonance imaging to assess functional changes in rat models following localized regenerative therapies, which may not be detected by conventional measures of global systolic performance.

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